Comparative Study of Urban and Rural Salts for Iodine Content

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Certification Statement

This is to certify that this project titled "**Comparative Study of Urban and Rural Salts for Iodine Content**" submitted for the partial fulfillment of the requirements for the degree of Bachelor of Pharmacy from the Department of Pharmacy, BRAC University constitutes my own work under the supervision of Ashis Kumar Podder, Lecturer, Department of Pharmacy, BRAC University and that appropriate credit is given where I have used the language, ideas or writings of another.

Signed,

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Countersigned by the supervisor

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DEDICATION

I dedicate this project work to my family.

Abstract

From the 18th century to till now the most notorious widespread public health crisis is iodine deficiency. Using iodized salt is the most effective strategy to fight against it. This paper is all about to assess the iodine concentration in available different branded and open salts from different rural and urban areas of Bangladesh. To measure the iodine level in salt samples, iodometric titration was used. The results show positive indication towards achieving our most desired goal of eliminating iodine deficiency disorders (IDD) from the country. Almost every branded salt sample contains iodine in the accepted range (minimum 20 ppm in consumption level and 50 ppm in production level). However, all the open salt samples showed poor iodine concentration (<5ppm). This indicates a large percentage of rural people are still in the risk of IDD only because of using these poorly iodized or non-iodized open salts. Government has achieved enormous success towards their goal of eliminating IDD particularly from urban areas of Bangladesh. Rural people are needed to make aware of using adequately iodized packet salts instead of poorly iodized or non-iodized open salts. Disseminating the consequences of iodine deficiency &benefits of using adequately iodized packet salts, re-pricing of packet salts considering the economic condition of rural people can be the only and effective strategy to boost up the usage of adequately iodized salts throughout the country.

Keywords: - Iodine deficiency disorders, open salts.

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ABBREVIATIONS

AIDS – Acquired Immune Deficiency Syndrome.

CT scan – Computed Tomography scan.

IDD – Iodine Deficiency Disorders.

DRI – Dietary Reference Intake.

DV – Daily Value.

HIV – Human Immunodeficiency Virus.

ICCIDD – International Coordinating Committee on Iodine Deficiency Disorders.

IQ – Intelligence Quotient.

ml – Milliliter

mcg – Microgram

MRI – Magnetic Resonance Imaging.

MT – Metric Ton.

UNISEF – United Nations International Children's Emergency Fund.

USSR–Union of Soviet Socialist Republics.

UN – United Nations.

USI – Universal Salt Iodization.

WHO – World Health Organization

INTRODUCTION

1.1 Background

In human diet, iodine is a must needed micronutrient for ensuring good health. It has many roles in human and animal body. The most important role of iodine is production of thyroid hormones T4 and T3. It also prevents human health from other abnormal health conditions. Natural foods do not contain as much iodine as human body needed that's why edible salt is fortified with iodine, which helps human body to maintain the daily requirement of iodine. It is also used to disinfect the drinking water and prevent surgical wound infection (Lingvay and Holt, 2012; Miller, 2006). Without it body fails to maintain its regular functional works like metabolism, mental growth and proper physical maturity and function at all development stages of life. Moreover, deficiency of iodine or iodide is responsible for physical as well as mental growth disturbances (cretinism, dwarfism), enlargement of thyroid gland (goiter), muscular disorders, and spontaneous abortions and hypothyroidism. For almost all this cases seen among newly born children, mother's iodine deficiency during pregnancy was found responsible (American Thyroid Association, 2007; Verma et al, 2001). Complete lack of thyroid hormones stops the functioning of thyroid gland. A healthy person needs to ingest about 50 milligrams of iodine in the form of iodide which is a year's requirement to form normal amount of Thyroxin. Abnormal enlargement of thyroid gland results from the insufficiency of iodine and a visible swelling in the front of human neck is considered as an iodine deficiency disease named goiter. As iodine level leads to the low level production of thyroid hormone it can also be a cause among women for losing her ability of fertility (Brownstein and David, 2008; Guyton and Hall, 2006). About one third of the world populations (approx. 1.6 billion) were at a demonic threat of IDD in 1920. In addition to this, the most shocking news was that only 20 percent of those IDD victims had access to iodized salt. In 1993, a global strategy known as Universal Salt Iodization (USI) was adopted for the elimination of iodine deficiency disorders, which states that all salt must be iodized before it is made available for the consumption of human and animal (Mannar and Bohac, 2009). Salt was chosen for iodization among the other foods because it is an excellent and safe carrier of iodine and consumed by all people at a relatively constant rate (Mannar and Bohac, 2009). To regulate the iodization program, WHO have recommended the iodine level (attach from literature) in the salt and urinary iodine excretion level for specific population group (UNICEF, WHO, 1994). Since then, adoption of USI had leaded the world to its great success of decreasing the number of IDD victims every year. Approximately 90 millions of newborn children were being saved every year from physical and mental disabilities which could be caused by IDD (WHO). As a later impact of USI strategy it was found that about 60 percent of all marketed salt were iodized in 1998 and in developing countries iodized salts were used by about 70 percent of household in 1999.A statistical report of a survey conducted in 2000, show that the birth rate of world children with the risk of IDD had been decreased into halves than it was in past years (Kiwanis International, 2011). The USI program was so successful in those days that it forced UNICEF to claim in 2011 that the world will welcome 85 million children with no risk of IDD (Kiwanis International, 2011).

USI strategy alone was a blind's step to hell but collaboration of it with national government, salt industry, international organization, community and maintaining of legislation on salt iodization made the milestone change in achieving the success (Mannar and Bohac, 2009). The main demand of USI program is establishing the commitment to IDD elimination by national government. Under this commitment the complete elimination of IDD must be supported by the countries legislation with the help of national government in its political level. The legislation made it mandatory of iodizing all available salt for the consumption of human and animals and observing this program for which a national body must be formed. This body will report to the Minister of Health and will also appoint an executive officer who will be responsible to his duty of IDD elimination program (WHO, UNICEF, ICCIDD, 2007).

1.2 Salt Iodization in Different Countries

It is known to all that in India's political history salt has an enormous place and this is all about the Gandhi's salt march to Dandi which was coined to show their protest to the taxation on salt in 1993. On that time there was no iodization of salt. Iodization of edible salt was introduced by Government of India in 1962 and it was operated in public sector from 1963 to 1982 under the controlled observation of National Goiter Control Program. In a view to increase the production and availability of edible iodized salt throughout the India, Government of India permitted the iodization of salt in private sector in 1983 which successfully led them to the Universal Salt Iodization (Sundaresan, 2008). In addition to this the Government of India introduced legislation in 1998 and this law banned the sale and manufacture of all kind of non iodized salt throughout the India. In 2000, this legislation was revoked because of political issues which resulted a huge fall in the production of adequately iodized salt. In 1997 the production of adequately iodized salt was estimated about 70.3 percent of total salt produced in India and in the time period of 2000-2004 it was fallen down to 29.6 percent due to unavailability of edible iodized salt throughout India which exposed its vast population in the vulnerability of IDD risk. However the entire situation was dramatically changed when the Government of India reinstated the law and again banned the production and selling of non iodized salt for human consumption in 2006. This reinstating of law increase the production and availability of iodized salt and it was estimated about 5.1 million tons of iodized salts were produced in 2007 which was more than in 1997 (4.1 million tons) and during the period of 2000-2004 (1.69 million tons) (Sundaresan, 2008; Vir, 2009).

In a view to uproot the risk of endemic goiter the government of former USSR adopted the salt iodization policy in 1950 which was ran under the ordinance of Ministry of Health of USSR. This policy was a successful one to them and they began to believe that the goiter problem was uprooted from their land finally. So in 1970 government stopped to trace down the goiter problem anymore and converted their major focus on other health care facilities (Mannar and Bohac, 2009). After the dissolution of USSR in 1991, Russia faced its major problem in making the availability of edible iodized salt for its vast population and continuously failed to meet the demand of edible iodized salt. In 1997 Russia could produce only 25,000 tons of edible iodide salt for its vast population and this huge lack of iodized salt reemerged the risk of IDD in Russia (Gerasimov, 2002). When the situation was getting worst day by day the collaborating work among the Russian Association of salt producers, the Russian Government, the Ministry of Health and supports from UNICEF and international organizations helped Russia to improve this problem. According to 2008 data, the amount of iodized salt production of Russia was about 130,000 tons where the domestic demand of iodized salt was about 500,000 tons and this big gap between demand and production of iodized salt resulted the low household consumption of iodized salt, which was about 29 percent (Gerasimov, 2009).

Endemic goiter and cretinism showed up in China as an epidemic disease in 1960 and to overcome these epidemic diseases an effective solution was found by them and the solution was none other than the consumption of iodized salt as diet (Yip et al, 2004). Before finding a way to address these endemic IDD, they faced the shocking truth about their public health. About 700 million people were at the risk of IDD. The situation was even worst in 1970 when they found out about 35 million people had visible goiter and 25 million people were having intellectual impairment and the main reason behind that was iodine deficiency (Qian, 2009). Though there were earlier efforts to address these public health problems effectively in those endemic areas but they failed in their mission due to proper observation on their commitment, improper salt iodization and lack of continuous monitoring (Yip et al, 2004). To eliminate this public health threat completely from their country China launched a dedicated era to eliminate IDD and signed the declaration for elimination of IDD as one of its goals on UN Summit for Children in 1990. So to make it happen Chinese Government made a formal commitment to eliminate IDD by the year of 2000. Within 1995, Universal Salt Iodization was adopted as their main strategy throughout the country (Yip et al, 2004). On consequences to this the successes of the strategy were reflecting all over China. China produced about 8 million tons of iodized salt in 2005 where in 1993 this amount was about 3.3 million tons. In addition to this about 96 percent of Chinese were using iodized salt as diet.

Thus government support, strong commitment for elimination of IDD, complete law and proper monitoring lead a nation to achieve the goal of eliminating the risk of IDD from a country by following Universal Salt iodization strategy.

1.3 Iodine

Iodine is one of the most necessary trace elements which helps in the synthesis of thyroid hormones. It is very reactive and posses different stereochemistry and several oxidation steps. In nature, the most stable form of iodine is iodine-127 and it appears bluish black in color. When it comes in contrast with high – energy particles like xenon it produce a small amount of radioactive iodine – 129. Both form of iodine has enormous effect on human body.

1.3.1 Sources

Iodine is a must needed micronutrient in human diet. Iodine is largely obtained from seas and soils. In the plants and animals iodine is found in varying amount. Sea fish and iodized salt is the most available and easy accessible source of iodine for human.

Table – 1: Most Available Dietary Sources of Iodine (American Thyroid Association, 2007)

Bread	Seaweed
Eggs	Frozen Yougut
Iodized Salt	Shellfish
Fish (Saltwater)	Soy Sauce
Eggs	Soymilk
Ice Cream	Cheese
Iodine Containing Multivitamins	Yoghurt

Table – 2: Healthiest foods of world and their nutrient evaluation (Iodine, Nutrient Rating Chart, the world's healthiest foods)

Name of food	Serving Size	Calories	Quantity (mcg)	DRI/DV (%)	Nutrient Density	World's healthiest food rating
Sea vegetables	1 TBS	10.8	750.00	500	829.5	Excellent
Scallops	4 oz	125.9	135.00	90	12.9	Excellent
Cod	4oz	96.4	132.00	88	16.4	Excellent
Yogurt	1 cup	149.4	71.05	47	5.7	Very good
Shrimp	4 oz	134.9	46.00	31	4.1	Very good
Cow's milk	4 oz	74.4	28.06	19	4.5	Very good
Eggs	1 each	77.5	27.00	18	4.2	Very good
Strawberries	1 cup	46.1	12.96	9	3.4	Very good
Sardines	3.20 oz	188.7	36.00	24	2.3	Good
Salmon	4 oz	157.6	32.00	21	2.4	Good
Tuna	4 oz	147.6	23.00	15	1.9	Good

1.3.2 Uses

A mixture of iodine and an alcohol which is also known as tincture of iodine used to treat wound and scarps on the skin. Silver iodide is used in the photography and lasers. The most effective use of iodine is counted in the condition with

a) too much thyroid gland activity (hyperthyroidism)
b) less thyroid gland activity (hypothyroidism)
c) skin infection caused by fungus *sporothrix*.

Other uses of iodine are listed below (Iodine, www.webmd.com) –

- Cardexomer iodine is used in case of leg ulcer to increase the healing rate of leg ulcer.
- In case of patient with hemodialysis catheters povidone iodine is used to reduce the risk of blood stem infection.
- The risk of inflammation of uterus is reduced by applying povidone iodine solution to the vaginal area before cesarean delivery.
- Taking of molecular iodine reduces painful fibrous breast tissue.
- Women with breast pain related to their menstrual cycle can reduce the pain and tenderness by taking iodine tablets daily for 5 months.
- Rinsing with povidone iodine can reduce gum infection.
- Povidone iodine is used during surgery to prevent the risk of infection at the surgical site.

Role of Iodine in Normal Metabolism

Metabolism is a biological process which helps to the conversion of food into energy. Human body utilizes this energy into other bioorganic events. Thyroid hormones regulate the normal metabolism of human body. Lack of thyroid hormones or complete lack of these hormones is responsible for the down fall of body's metabolism function rate up to 40 to 60 percent. This lack of thyroid hormones only results from the insufficiency of iodine (Brownstein and David, 2008; Guyton and Hall, 2006).

Role of Iodine in Healthy Pregnancy

Iodine plays the critical role to maintain adequate and perfect neuropsychological development of fetus throughout gestation and in the two year of life of a newly born baby. During pregnancy, thyroid gland uptake iodine higher than the preconception level and the reserve of iodine in thyroid is 40 percent less than a preconception level. If there is not sufficient store of iodine in thyroid in preconception state a woman can never overcome this iodine deficiency during her pregnancy state because of increasing demand of iodine during pregnancy. This can result in a hypothyroxinaemic state (Smyth, 2006). It is observed that maternal thyroid gets its extra demanded thyroid hormone successfully during their pregnancy in the areas with moderate to mild iodine deficiency (Zimmerman, 2009).

It takes about 13- 15 weeks to develop thyroid in fetus during gestation. In this long duration fetus rely completely on its mother's thyroid hormone supply (Glioner, 1997; Perez-Lopez, 2007). Within the third trimester fetus become able to function its own thyroid gland but still it depends on mother's thyroid hormone supply as its ability to produce thyroid hormones is very little (Becks and Burrow, 2000).

Moreover the only available resource of iodine for newly born infants is mother's milk and the amount of iodine in mother's milk is totally dependent onto maternal dietary iodine intake (NHMRC, 2009). . It was observed that the volume of thyroid gland was increased in pregnant women in iodine deficient areas. On the other side pregnant women in the area with sufficient supply of dietary iodine shows no visible change in the volume of thyroid (Glioner, 1997; Perez-Lopez, 2007; Zimmerman, 2009).

Role of Iodine in Apoptosis and Cancer

Apoptosis or programmed and highly controlled cell suicidal event. In case of multicellular organisms whenever group of cells make a threat to the respective organism or group of cells that are no longer needed to respective organism then to protect the organism from the unwanted apoptosis occurs. That why apoptosis is a crucial part for the treatment of tumor and cancer cells. Iodine plays a vital role for the induction of independent apoptosis in cancer cells and tumor cells. This role of iodine is considered as extra thyroidal benefits of iodine.

In vitro it is observed by Zhang and co workers that induction of apoptosis process by iodine in modified cancer cell can kill 95% of cancerous cell. This lung cancer cell was modified with genes which enhance the uptake of iodine and iodination process of protein. When the same experiment was performed in mice great success was observed as iodine suppress abnormal growth of genetically manipulated xenografts (Zhang et al, 2005)

Mekabu(seaweed),a rich source of iodine has been also found to induce apoptosis process in breast cancer cell. Effect of Mekabu on cultured breast cancer cell was studied by Sekiy et al. It was observed that by activating caspases 3, 6 and 8 Mekabu induces apoptosis process into cultured breast cancer cell (Sekiya et al, 2005). Another experiment has been done by Shivastava and co worker recently, which showed apoptosis process can be initiated by molecular iodine (I_2) in the breast cancer cells of women by using caspase – which is considered as an independent and mitochondrial mediated apoptotic pathways (Shrivastava et al, 2006). Iodine showed effective and successful result when it shows its preventing capability against breast cancer cells in rats. Garcia Solis and co worked observed this successful experiment when rats are given with nitrosomethyl urea carcinogen (Garcia-Solis et al, 2005).

Role of Iodine as an Antioxidant

Inorganic iodine functions as an antioxidant and it was shown by Kupper et al. in *Laminariales*which is a species of Kelp. Here neutralization of hydrogen peroxide occurs in two steps. The first step is all about converting it into hypoiodous acid and the second step is converting it into water and thus this step conversion process prevents the formation of hydroxyl radical. Moreover, under oxidative stress this alga absorbs increased amount of iodine (Küpper et al, 1998). It is also shown by other researchers that iodine is a specific hunter of hydroxyl radicals, (Murata et al, 1986) Iodine has the capability in boosting the antioxidant property of human blood(Winkler et al, 2000). Rat's brain cells are being protected from lipid peroxidation process by iodine. It also makes the brain cells less susceptible to free radical.(Katamine et al, 1985; Cocchi and Venturi, 2000). Cyanobacteria which are also known as blue green algae have great affinity to iodine. In the process of photosynthesis, conversion of 6 molecule of $CO_2$and 6 molecule of H_2O into 1 molecule of $C_6H_{12}O_6.H_2O$ (dextrose) and as a waste product 6 molecule of O_2 is being produced by cyanobacteria. It is believed that iodine serves as an antioxidant in case of cyanobacteria while iodine is considered as toxic to all other non photosynthetic bacteria.

Cyanobacteria are considered as large source of oxygen in earth's atmosphere. Algae is a good dietary source of organic iodinated molecule as it also posses the photosynthetic process.

Iodine and Delayed Immunity

The therapeutic effect of iodine is very important in case of patient with syphilitic, lepromatous, tubercular glaucomatous and msycotic lesions. In case of these complications patients are given iodine with a view to boost up immune response. Iodine's this kind of effect does not depends on those pathogens which are actually responsible for diseases. Use of iodine is also found effective in case of sweet syndrome, erythema nodosum, erythema multiform, villanova – panolpanniculities and nodular vasculities. A human study was done in a area of endemic goiter to show the world about the shared relation between immune response and intake of dietary iodine. This study was done on 607 infants and these infants were grouped into two group where one group was consisted of 215 infants and the other group was consists with 392 infants. In case of group of 215 infants Lugol solution was given to them and the dose was two drops a week for eight months. Groups with 392 infants were not treated with anything. After conducting the tetanic toxoid skin test a visible difference were observed in case of average diameter of infiltration. This human study was successfully ended with a significant result which told intake of dietary iodine adequately influences the body immune responses (Brownstein and David, 2008)

These T_3 and T_4 hormones have great effect on metabolism and brain development. Thyroid hormones also regulate nervous system, muscle strength, menstrual cycle, body temperature, skin dryness, cholesterol level and body weight. Calcitonin, an important hormone for the metabolism of calcium is also produced by thyroid gland.

Table – 3: Recommended Dietary Allowance (RDAs) for Iodine (Institute of Medicine, Food and Nutrition Board, 2001)

Age Range	For Male	For Female	During Pregnancy Period	During Breast Feeding Period
Birth to 6 month	110 mcg*	110 mcg*		
Infants (7- 12 month)	130 mcg*	130 mcg*		
1-2 years	90mcg	90 mcg		
4-8 years	90 mcg	90 mcg		
9-13 years	120 mcg	120 mcg		
14-18 years	150 mcg	150 mcg	220 mcg	290 mcg
Adults 19+ years	150 mcg	150 mcg	220 mcg	290 mcg
*Adequately Intake (AI); WHO, UNICEF, ICCIDD and other international organization recommended iodine intake 250mcg per day for pregnant women.				

1.3.3 Iodine Deficiency Disorder

Severe internal brain cell injury and inadequate mental developments are the main complications caused from the intake of insufficient iodine or lack of adequate iodine concentration in body. Along with these disorders endemic goiter, muscular disorder, dwarfism, cretinism, spontaneous abortions and still birth are the disorders which can affect human health. Moreover iodine deficiency not only affects a person's health individually but also the entire community. It was reported by ICCIDD that, IDD is the main reason for low IQ level of an entire community and in iodine deficient community the average IQ level is 13.5 point less compared to other community. As a result of this the socio economic developments are seen less in iodine deficient community. Lack of innovation, difficulty in learning and difficulty in adopting new technologies toward productive economy is the main reason for this less socio economic development (Verma et al, 2001; WHO, UNICEF, ICCIDD, 2007).

Causes of Iodine Deficiency

Human body does not have the ability to produce iodine itself, so iodine is supplied into human body as diet. So iodine deficiency can be raised by not having sufficient amount of iodine as diet (American Thyroid Association, 2007). Action of deforestations, aged old ancient farming methods and soil erosions are the main reasons of mineral depletion from the soils and this lead to iodine deficient crops. Moreover, toxic chemicals like halides affect the uptake of iodine by bodily tissues into human body. This group of halides consists of bromide, chloride, fluoride and iodide. Among these chemicals only iodide has the therapeutic effect on human body. Rest chemicals compete for iodine receptors and bind with iodine receptors as they have similar chemical structure like iodine and iodine receptors failed to recognize them individually which results less or no absorb of iodine by body tissue and expose the human health at the risk of IDD. Bromine causes breast cancer. The risk of IDD was increased tremendously when iodine was replaced by bromine as an ingredient of bread dough in 1980. This single change caused bromide toxicity which exposed the human health into cancerous diseases, thyroid disorder, thyroid cancer and deficiency of iodine caused other disorders. Our toothpaste, water and pharmaceutical products contain chloride and fluoride and these chemicals block the iodine receptors by binding with them. Halides binding with iodine receptor in human body can be prevented by maintaining iodine saturation level in bodily tissue. Iodine saturation level in bodily tissue also helps in the excretion of these harmful halides from the body (Brownstein and David, 2008).

Diagnosis of Iodine Deficiency Disorder

Iodine deficiency can’t be diagnosed in individual level but it has to be diagnosed into a particular population. To diagnose iodine deficiency the most effective method is the determination of the amount of iodine in urine. So urine samples were collected across the particular population and the amount of iodine in urine samples are subjected to study. If the mean iodine concentration in urine is not as much of 50 μg/L then that particular population is referred as iodine deficient.

Table – 4: Mean Iodine Concentration in Urine comparing with Daily Intake of Iodine (American Thyroid Association, 2007)

Mean Iodine Concentration in Urine (µg/L)	Daily Intake Of Iodine (µg/day)	Deficiency Level
Less than 20	Less than 30	Severe Iodine Deficiency
In between 20-49	In between30-74	Moderate Iodine Deficiency
In between 50-79	In between 149-175	Mild Iodine Deficiency
In between 100-199	In between 150-299	Optimal Level of Iodine
In between 200-299	In between 300-449	More than adequate Level
More than 299	More than 449	Possible excess Level of Iodine

Iodine Deficiency and Pregnancy

Impact of iodine deficiency during pregnancy is very crucial. It has reported that pregnant woman with severe iodine deficiency give birth of children with the risk of IDD. In the long run these children can have problem with growth, hearing, speech and mental retardation. Mild iodine deficiency can be treated during pregnancy period by giving large quantity of iodine supplement. However in critical cases of iodine deficiency it is quite impossible treating iodine deficiency by giving large quantity of iodine supplement during pregnancy. As a result preterm delivery, stillbirth, miscarriages problems are observed in case of severe iodine deficient pregnant women. In addition to this, infant of iodine deficient mother can be a worst sufferer of congenital abnormalities. In today's world congenital hypothyroidism is the main reason for mental retardation in children. In case of severe iodine deficiency an under active thyroid can lead towards cretinism (American Thyroid Association, 2007; Smyth, 2006).

Iodine Deficiency in the Fetus

During gestation it takes about 13 – 15 weeks for the development of thyroid in the fetus. During this long period fetus completely depend on maternal thyroid hormone supply for its neuropsychological development. Deficiency of iodine in maternal body produces less hormones than it needed which results the improper neuropsychological development in fetus. This causes cretinism in children. Iodine deficiency in fetus can results in dwarfism too (Glione, 1997; Smyth, 2006; Hetzel, 1993).

Iodine Deficiency in the Children and Adolescent

The most common iodine deficiency disorder in this period is endemic goiter. The dominance of endemic goiter is seen in early ages and it increases with the age and the most developed form of endemic goiter is seen in the age of 12. However this condition can be cured by maintaining required iodine level for the body (Hetzel, 1993)

Iodine Deficiency in Adults

Goiter which is the most prominent form of iodine deficiency disorders is observed largely in adult people. Most commonly endemic goiter is associated with lack of concentration. So in iodine deficient areas the most common character among the population is lack of innovation and decision making skill.

Treatment

The treatment of iodine deficiency disorder is not a complicated one like treatment of cancer or treatment of HIV AIDS. It is most simple and available treatment. Intake of iodized salt is the most preferable treatment of IDD. According to WHO it takes only $0.05 yearly for a person to prevent IDD. In a whole life time a person needs only a teaspoon of iodine. Though a person need only a teaspoon of iodine throughout his whole life time but fragmented amount this small amount needs to provide on a daily basis to prevent IDD. In addition to this iodized products like vegetable oil, drinking water, vitamins are also used in the treatment of IDD. Iodized vegetable oil are also available in intramuscular injection form. In case of pregnancy mild deficiency can be a reason for negative effect on delivery and development of baby. So, pregnant women with mild iodine deficiency are prescribed multivitamin which contain at least 150µg iodine per day (American Thyroid Association, 2007).

Iodine Deficiency Disorders –

1.3.3.1 Hyperthyroidism

Thyroid gland is responsible for the formation of thyroid hormones triiodothyonine and Thyroxin. When thyroid gland produce excessive amount of thyroid hormone than a normal required amount and maintain a high level of thyroid hormone in blood then this abnormal condition of thyroid gland is called as hyperthyroidism. This condition is also known as thyrotoxicosis.

Symptoms

As the major role of thyroid hormone is all about controlling the metabolism in human body, the excess amount of thyroid hormone is responsible for hyper – metabolic state. In addition to this rapids heart rates, loss of body weight and heat intolerance are the most common symptoms which is observed in people with hyperthyroidism. In many cases visible goiter (enlargement of thyroid gland) is also seen. People can also encounter with high blood pressure, nervousness, hand tremors, excessive sweating, feeling of hungry and restless, difficulty in concentrating and increase number of bowel movement in case of hyperthyroidism condition. Moreover, irregular menstrual cycle is observed in case of women suffering from hyperthyroidism. Further symptoms are –

- Feeling of sickness
- Asymmetrical heartbeat
- Trouble in sleeping
- Itching
- Baldheadedness
- Unsettled stomach and vomiting

Causes

Hyperthyroidism can be results from various abnormal physical conditions. The most common reason is Graves' disease, which is an autoimmune disorder. In this case antibodies stimulate thyroid gland to secrete excessive amount of thyroid hormones. More causes of hyperthyroidism are –

- One or more thyroid nodules
- Thyroiditis.
- Ovarian or testes tumor
- The thyroid or pituitary gland tumor (Benign form)
- Too much use of synthetic thyroid hormone in the medication process of under active thyroid.

Diagnosis

Evaluating of symptoms and physical exam is the first step of diagnosis of hyperthyroidism. Other tests are performed for the further evaluation of diagnosis. These tests are –

- Cholesterol level test – Cholesterol level has an opposite relationship with metabolic rate. In hyperthyroidism, low level of cholesterol is observed due to high rate of body metabolism. .
- Thyroid hormone test – Amount of thyroxin and triiodothyonine hormone in a patient's blood can be determined by performing this test.
- Thyroid Stimulating Hormone level test – This test is performed for determining the level of thyroid stimulating hormone. It should be in a normal range.
- Triglyceride Level Test – In hyperthyroidism low level of triglyceride is observed.
- Thyroid scan and uptake – It shows whether the thyroid gland is overactive or not. It also give the information about the single area of a thyroid gland or a entire thyroid gland causing the over activity.
- Ultrasound - The total size of thyroid gland is measured by ultrasound technique. One can know about the mass (Solid or cystic) of thyroid gland using ultrasound.
- CT scan or MRI –When physician suspect about pituitary tumor only then CT scan test is performed.

Treatment

Antithyroid medication and radioactive iodine is the first line medication for hyperthyroidism treatment. Antithyroid medication inhibits the formation of Thyroxin and triiodothyonine hormone. Destruction thyroid hormone producing cells are done by radioactive iodine. On the opposite side these medication has severe side effects like low level of white blood cell.

Sometimes surgery is performed for partial or entire removal of thyroid gland. In this case thyroid hormone supplements are taken to prevent hypothyroidism.

(Hyperthyroidism, www.healthline.com)

1.3.3.2 Hypothyroidism

Hypothyroidism is one of the abnormal conditions of thyroid gland which associated with production of insufficient thyroid hormone. One of the major functions of thyroid gland is functioning the metabolism in appropriate rate and in this case slow metabolism is observed among the patient suffering from hypothyroidism. It is hypothyroidism which is the most common form of iodine deficiency disorder in the current world. Currently millions of people are hypothyroid and they totally have no idea about having this disease.

Symptoms

The symptoms of hypothyroidism are associated with the deficiency level of thyroid hormones and can be vary from person to person. Body's deprivation time period of thyroid hormones is also associated with it. Common symptoms related to this form of iodine deficiency disorder is given below –

- Constipation
- Weight loss
- Memory loss
- Felling of sick
- Muscle cramps
- Dry hair
- Whitish skin

- Intolerance of cold
- Loss of energy
- Bad temper
- Irregular menstrual cycle

Causes

Hypothyroidism has two major causes. The first one is associated with Thyroid gland inflammation. Due to this inflammation a big percentage of thyroid cells get destroyed or became partially damaged and they loss their ability of producing adequate amount of thyroid hormones. This inflammation is done by autoimmune response of antibody. It is the most general reason for the failure of thyroid gland.

The second major cause of hypothyroidism is associated with medical treatment in case of other thyroidal abnormalities. Other abnormal thyroid condition can be a reason for removal of entire thyroid gland or a large portion of thyroid gland surgically and for this thyroid failed to produce sufficient amount of thyroid hormone or complete lack of thyroid hormone for human body and give raise the abnormal thyroidal condition named hypothyroidism. Excessive antithyroid medication and treatment with radioactive iodine in the case of hyperthyroidism could be the reason for hypothyroidism.

Diagnosis

Evaluating of symptoms and physical exam is the first step of diagnosis of hypothyroidism. Other tests are performed for the further evaluation of diagnosis. These tests are –

- Cholesterol level test – Cholesterol level has an opposite relationship with metabolic rate. In hypothyroidism, high level of cholesterol is observed due to low level of body metabolism.
- Thyroid hormone test – Amount of thyroxin and triiodothyonine hormone in a patient's blood can be determined by performing this test
- Thyroid Stimulating Hormone level test – This test is performed for determining the level of thyroid stimulating hormone. It should be in a normal range.
- Thyroid gland functioning test

Treatment

Administration of thyroid hormone in pill form is the most effective and available treatment. It is all about replacement of thyroxin hormone that human thyroid gland produce with pure synthetic form of thyroxin hormone (T4).(Hypothyroidism, www.endrocrineweb.com)

1.3.3.3 Goiter

Goiter is associated with enlargement of thyroid gland. This enlargement of thyroid gland can be associated with the increased number of thyroidal cells or hypertrophy of individual thyroidal cells. This increase number of cells or increased sizes of individual cells are result from the increased number of TSH which indicates the decreased level of thyroxin and triiodothyonine hormone in the blood. Two types of goiter is seen in human thyroid gland, one is diffuse goiter and the other one is nodular goiter. Goiter which has the capability of producing sufficient amount of thyroid hormones is known as euthyroid or non-toxic thyroid, goiter which produce more than sufficient level of thyroid hormone known as toxic goiter and goiter which produce insufficient level of thyroid hormone known as goitrous hypothyroidism.

Symptoms

The most common and visible symptom of goiter is swelling or lump on the front neck. This is due to the enlargement of thyroid gland. In case of mild goiter there is no symptom and thyroid can function normally. However, in severe cases enlargement of goiter prevent smooth swallowing of food, disturbs in chewing and speaking. Other symptoms of goiter include –

- Cough
- Difficulty in breathing
- Dizziness
- Hoarse voice
- Sore throat
- Vain swallowing
- Pain and tenderness

Causes

Endemic goiter which is also called as colloidal goiter arise due to the iodine deficiency. Lack of iodine is the main reason for producing insufficient amount of thyroid hormone and this results the swelling of thyroid gland.

Sporadic goiter or nontoxic goiter occurs due to genetics, medication side effect and other diseases or disorders of the thyroid.

Thyroid gland swelling is associated formation of tumor or inflammation of thyroid gland.

Treatment

Goiter doesn't need any kind of treatment if the symptoms are not that much problematic. Treatments for problematic simple goiter are –

- Iodine supplements (Lugol's solution or potassium iodine)
- Radioactive iodine to decrease thyroid hormone production
- Surgery to remove excess thyroid tissue
- Thyroid hormone therapy.(Goiter, www.healthgrades.com; Zoe,2006; Landerson, 2008)

1.3.3.4 Cretinism

Cretinism indicates that medical condition which present in infant from the time of their birth and it emerge into infant when there is decreased or absent of thyroid function and thyroid hormone production. It causes the severely stunted physical and mental growth of newly born infants. Cretinism is also known as Congenital Hypothyroidism.

Symptoms

The following symptoms are observed in the case of cretinism -

- Fontanelles : Larger anterior fontanel
- Low hair line, dry brittle hair
- Infant's face looks dull, puffy and have slow reaction
- Large tongue, thick and protruding
- Yellowish discoloration of the skin

- Hyperthermia
- Hypotonia
- Difficulty of breathing
- Bradycardia, heart valve abnormality
- Poor feeding
- Choking
- Excessive sleeping
- Decreased activity
- Constipation
- Short stature

Causes

Cretinism in the newly born infants may be caused from –

- Heredity in origin
- Missing or misplaced thyroid gland
- Maternal Iodine deficiency
- Maternal thyroid condition and medication
- Dysfunction of pituitary gland/hypothalamus

Diagnosis

The following tests are performed to sure about cretinism –

- Newborn screening test – helps to detect the metabolic and genetic disorder
- Measurement of TSH or Thyroxin (T4) – High level of TSH and low level of T4 confirm cretinism or congenital hypothyroidism
- Technetium thyroid scan – Detects any structural abnormality in thyroid
- X – rays of baby's leg

Treatment

Replacement of thyroid hormone with L-Thyroxin throughout whole life is the most common treatment of cretinism. Along with it monitoring and evaluation of personal behavior, motor ability, adaptive behavior and language ability is also a part of cretinism treatment. (Cretinism, howshealth.com).

1.3.4 Iodine Deficiency in Bangladesh

On health bulletin 2013, it is reported that iodine deficiency disorders are observed in 40% of 10-13 years (school age) old children and the prevalence of iodine deficiency among the non-pregnant and nulliparous women was about was 42.1%. Iodized salt (iodine level ≥5 ppm) was used by 80% of house hold but adequately iodized salt (iodine level ≥15 ppm) was used by 57.6% households. Only 51.8% villager use adequately iodized salt in village area. The national rate of using Brand salt is about 75.8% but still in rural areas about 30% household uses open salt. The first goiter rate 28.9% was published by The Nutrition Survey of East Pakistan on 1962–1964 report. Later goiter rate was found about 47.1% on 1993 by The National Iodine Deficiency Disorder survey (Health Bulletin, 2013).

MATERIALS AND METHODS

2.1 Study Design

This study was designed for determining the iodine content of several branded salts (8) and open salts (13) that were collected from different village markets of Bangladesh. Study was conducted between July and August of 2015.

2.2 Chemicals and Reagents

- Sodium Thiosulphate
- Potassium Iodate
- Potassium Dichromate
- Sodium Bicarbonate
- Concentrated Hydrochloric Acid
- Concentrated Sulfuric Acid
- Starch
- Distilled Water

2.3 Glass Apparatus and Accessories

- Volumetric Flask (50ml, 250ml, 1000ml)
- 250 ml Conical Flask
- Watch Glass
- 50 ml Burette
- Burette Stand
- Funnel
- Measuring Cylinder
- Beaker
- 5ml Pipette
- Pipette Pump
- Spatula
- Dropper

2.4 Equipments

- Hot plate
- Electronic Balance
- Distillation Equipment

2.5 Methods

Principle

Now a day's most of the salts are fortified with potassium iodate (KIO_3). Potassium iodate contains 59.5% of elemental iodine. Iodometric titration is the most used and easiest process which helps to measure the amount of iodine exist in iodated salt. DcMaeyer, Lowenstein and Thilly describe an iodometric titration procedure in 1979. On their iodometric process the following reactions were occurred –

1. $IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O$

(From Salt) (From KI) (From H_2SO_4)

2. $2Na_2S_2O_3 + I_2 \longrightarrow NaI + Na_2S_4O_6$

Sodium thiosulphate, Iodine, Sodium Iodide, Sodium terathionate

In the first step of reaction, free iodine is liberated from salt

- Salt sample contains iodate from which free iodine is liberated by reacting with H_2SO_4.
- Free iodine is being solubilised by adding extra KI iodine in the sample solution. In normal condition it is quite impossible for KI to be soluble in pure water.

In the second step of reaction sodium thiosulphate is used against free iodine to proceed the titration process.

- In this titration process sodium thiosulphate neutralizes free iodine present in the sample solution. Liberated free iodine is calculated from the proportional relationship between amount of free iodine and the amount of sodium thiosulphate which neutralizes the free iodine.

- In this reaction process starch is used for indication purpose and it gives deep blue color indicating reaction between starch and free iodine. Turning of this deep blue color solution into a clear solution indicates sodium thiosulphate has neutralized all of the free iodine. The related chemical equations at various steps are as follow,

$$\mathbf{IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2 + 3H_2O}$$

$$\mathbf{I_2 + I^- \longrightarrow I_3^-}$$

$$\mathbf{I_3^- + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 3I^-}$$

The overall reaction is, $\mathbf{IO_3^- + 5I^- + 6S_2O_3^{2-} \longrightarrow 3S_4O_6^{2-} + 6I^- + 3H_2O}$

So, $\mathbf{IO_3^-} \equiv \mathbf{I^-} \equiv \mathbf{6S_2O_3^{2-}}$ [Extra $\mathbf{5I^-}$ comes from KI solution]

Or, 214.0g of KIO_3 ≡ 126.9g of Iodine ≡ 6000 ml 1N thiosulphate solution

Or, 35.67g of KIO_3 ≡ 21.15g of Iodine ≡ 1000 ml 1N thiosulphate solution

Or, 35.67mg of KIO_3 ≡ 21.15mg of Iodine ≡ 1ml 1N thiosulphate solution

Or, 0.17835mg of KIO_3 ≡ 0.10575mg of Iodine ≡ 1ml 0.005N thiosulphate solution

Preparation of 0.005 N Sodium Thiosulphate ($Na_2S_2O_3$) solution:

$$\mathbf{2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2e}$$

So, 2 × 248 g $Na_2S_2O_3.5H_2O$ ≡ 2000 ml 1N

Or, 248 g $Na_2S_2O_3.5H_2O$ ≡ 1000 ml 1N

Or, 1.240 g $Na_2S_2O_3.5H_2O$ ≡ 1000 ml 0.005N

1.240 g of sodium thiosulphate was dissolved in 1000ml hot water.

Preparation of 0.005 N Potassium dichromate ($K_2Cr_2O_7$) **solution:**

Molecular weight of $K_2Cr_2O_7$ = 294g

Equivalent weight of $K_2Cr_2O_7$ = 49g

Calculation:

For 1000 ml 1N equivalent weight = 49g

For 1 ml 1N equivalent weight = 49/1000 g

So, for 50ml of 0.005 N equivalent weight = 12.25 mg

12.25 mg of $K_2Cr_2O_7$ was accurately weighted with the help of electronic balance and this was taken into a volumetric flask with the help of a funnel. Small quantity of distil water was added through the funnel into the flask. Then potassium dichromate was dissolved into the water by shaking. Then the volume of the solution was adjusted up to 50 ml by distilled water.

Standardization of 0.005 N $Na_2S_2O_3$ solution:

It is done by the titration of iodine in presence of potassium iodide with a known volume of acidified standard potassium dichromate solution. Thoisulfate reacts with iodine (I_2) to give iodide ion (I^-), which is produced after the reaction between KI and potassium dichromate. Potassium iodide oxidizes by potassium dichromate to produce iodine. Then soluble triiodide is produced from iodine by reacting with potassium iodide. Finally this triiodide reacts with sodium thiosulphate to produce sodium tetrathionate.

$$Cr_2O_7^{-2} + 6I^- + 14H^+ \longrightarrow 2Cr^{+3} + 3I_2 + 7H_2O$$

$$I_2 + I^- \longleftrightarrow I_3^-$$

$$I_3^- + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + I^-$$

The overall reaction is, $Cr_2O_7^{-2} + 6I^- + 6\ S_2O_3^{2-} \longrightarrow 2Cr^{+3} + 3S_4O_6^{2-} + 6I^- + 3H_2O$

Or, $Cr_2O7^{-2} + 6\ S_2O_3^{2-} \longrightarrow 3S_4O_6^{2-} + 3H_2O$

[Three I_2 from each $K_2Cr_2O_7$and each I_2 reacts with two $S_2O_3^{2-}$, so each $K_2Cr_2O_7$ reacts with six $S_2O_3^{2-}$]

Standardization steps of 0.005 N $Na_2S_2O_3$ solution–

a) In a 250 ml conical flask 1gm of KI and 1gm of $NaHCO_3$ were taken.

b) Then 10 ml of 0.001 N of potassium dichromate and 25 ml of water was added into the flask.
c) Then the flask was swirled to mix the content.
d) After mixing of contents, 5ml of conc. HCl was added to the conical flask.
e) Then the flask was covered with watch glass and the contents were mixed gently.
f) Then the flask was kept into a dark place for 7 to 8 minutes.
g) $Na_2S_2O_3$ solution was taken into the burette.
h) After that, the mixture was titrated against $Na_2S_2O_3$ solution.
i) The color of dichromate solution turned deep brown to lighter color as titration proceeds.
j) Then few drops of 1% starch solution were added to the mixture.
k) The solution was turned into deep blue color as starch solution reacts with free iodine present in the mixture solution.
l) The whole solution was turned into clear solution at the end point of titration indicating consumption of all the liberated iodine.
m) The burette reading of $Na_2S_2O_3$ solution was recorded and the same process was repeated for two more times.
n) Then the average volume of $Na_2S_2O_3$ solution required for titration was calculated.
o) Then this average volume of $Na_2S_2O_3$ solution was used to calculate the strength of sodium thiosulphate.

Preparation of 2N sulfuric acid (H_2SO_4):

2.8 ml concentrated H_2SO_4 was added drop wise into a 40 ml of chilled distilled water and then the final volume was adjusted up to 50ml mark.

Preparation of 10% Potassium iodide solution:

25 gm of potassium iodide was dissolved into water and volume was adjusted up to250 ml.

Preparation of 1% starch solution:

To prepare 1% starch solution, 500 mg of water soluble starch was weighted using electronic balance and then it was dissolved in 50 ml hot boiled water. Here conical flask was used as solution vessel. Continuous stirring helped to dissolve the starch into hot boiled water perfectly. This starch solution was then cooled up to room temperature for use.

2.6 Titration of samples:

a) 25g of salt sample was accurately weighed and transferred into a 250 ml conical flask. Distilled water was added to dissolve the sample.
b) To the sample solution 1ml of 2N H_2SO_4 solution was added.
c) The solution was kept for attaining normal temperature and after that, 5ml of 10% KI solution was added.
d) The flask was sealed with stopper and was kept into a dark place for about 5 minutes.
e) As the iodine was produced in the solution the color of the solution turned into yellow/brown.
f) Then the burette was rinsed and filled with 0.005N $Na_2S_2O_3$ solution.
g) Then the sample solution was titrated against 0.005N $Na_2S_2O_3$ solution until the color of sample solution turns into straw yellow.
h) Few drops of freshly prepared and cooled starch solution which turned the sample solution to deep blue indicating the presence of free iodine in the sample solution.
i) The titration was continued until the solution became colorless.
j) The process was repeated twice more and an average value for the volume of $Na_2S_2O_3$ was determined.

RESULTS AND DISCUSSION

3.1 Calculation

$$1ml\ 0.005N\ Na_2S_2O_3 \text{ solution} \equiv 0.10575mg \text{ of Iodine}$$

$$\Rightarrow X\ ml\ 0.005N\ Na_2S_2O_3 \text{ solution} \equiv (0.10575 \times X) \text{ mg of Iodine}$$

$$\Rightarrow X\ ml\ 0.005N\ Na_2S_2O_3 \text{ solution} \equiv (0.10575 \times X) / 1000 \text{ g of Iodine}$$

ppm conversion of Iodine

25 g sample salt contains $(0.10575 \times X) / 1000$ g of Iodine

So, 10,00,000g sample salt contains $(0.10575 \times X \times 10,00,000) / (1000 \times 25)$ ppm of Iodine

Standardization of $Na_2S_2O_3$ solution:

Table – 5: Standardization of $Na_2S_2O_3$ solution

Observation No.	Initial Burette Reading (ml)	Final Burette Reading (ml)	Difference (ml)	Average (ml)
01	00.00	10.00	10.00	10.16
02	10.00	20.40	10.40	
03	20.40	30.50	10.10	

The strength of $Na_2S_2O_3$ is calculated using the following formula:

Volume of $Na_2S_2O_3$, $V_1 = 10.16$

Strength of $K_2Cr_2O_7$, $S_2 = 0.01N$

Volume of $K_2Cr_2O_7$, $V_2 = 10$ ml

$$\mathbf{S_1 \times V_1 = S_2 \times V_2}$$

So, $S_1 = (S_2 \times V_2)/V_1 = (0.005 \times 10)/10.16 =$ **0.0049N**

3.2 Result

Acceptable Iodine ppm level is maximum 50 ppm at production level and minimum 20 ppm at selling period (National Salt Policy, 2011). Following results were obtained for each sample by following previously mentioned methods and titration steps:

Table – 6: Iodine content of sample salts

Sample	Observation No.	Initial Burette Reading (ml)	Final Burette Reading (ml)	Difference (ml)	Average (ml)	Iodine (ppm)
BS-1	01	00	9.0	9	9	38.07
	02	9.0	18	9		
	03	18	27	9		
BS-2	01	00	9.6	9.6	9.53	40.31
	02	9.6	19.2	9.6		
	03	19.2	28.6	9.4		
BS-3	01	00	6.7	6.7	6.76	28.59
	02	6.7	13.4	6.7		
	03	13.4	20.3	6.9		
BS-4	01	00	4.4	4.4	4.6	19.46
	02	4.4	9.1	4.7		
	03	9.1	13.8	4.7		
BS-5	01	00	7.2	7.2	7.23	30.58
	02	7.2	14.6	7.4		
	03	14.6	21.7	7.1		
BS-6	01	00	9.8	9.8	9.76	41.28
	02	9.8	19.5	9.7		
	03	19.5	29.3	9.8		
BS-7	01	00	4.5	4.5	4.53	19.16
	02	4.5	9.2	4.7		
	03	9.2	13.6	4.4		
BS-8	01	00	6.3	6.3	6.46	27.33
	02	6.3	12.8	6.5		
	03	12.8	19.4	6.6		

Sample	Observation No.	Initial Burette Reading (ml)	Final Burette Reading (ml)	Difference (ml)	Average (ml)	Iodine (ppm)
OS-1	01	00	0.7	0.7	0.6	2.54
	02	0.7	1.3	0.6		
	03	1.3	1.8	0.5		
OS-2	01	00	0.2	0.2	0.2	0.85
	02	0.2	0.4	0.2		
	03	0.4	0.6	0.2		
OS-3	01	00	0.3	0.3	0.33	1.39
	02	0.3	0.7	0.4		
	03	0.7	1.0	0.3		
OS-4	01	00	0.3	0.3	0.36	1.52
	02	0.3	0.7	0.4		
	03	0.7	1.1	0.4		
OS-5	01	00	0.1	0.1	0.16	0.68
	02	0.1	0.3	0.2		
	03	0.3	0.5	0.2		
OS-6	01	00	0.2	0.2	0.26	1.09
	02	0.2	0.5	0.3		
	03	0.5	0.8	0.3		
OS-7	01	00	0.1	0.1	0.13	0.55
	02	0.1	0.2	0.1		
	03	0.2	0.4	0.2		
OS-8	01	00	0.1	0.1	0.1	0.42
	02	0.1	0.2	0.1		
	03	0.2	0.3	0.1		
OS-9	01	00	0.3	0.3	0.33	1.39
	02	0.3	0.7	0.4		
	03	0.7	1.0	0.3		
OS-10	01	00	0.1	0.1	0.16	0.68
	02	0.1	0.3	0.2		
	03	0.3	0.5	0.2		

Sample	Observation No.	Initial Burette Reading (ml)	Final Burette Reading (ml)	Difference (ml)	Average (ml)	Iodine (ppm)
OS-11	01	00	1.0	1.0	0.96	4.06
	02	1.0	1.9	0.9		
	03	1.9	2.9	1.0		
OS-12	01	00	0.8	0.8	0.86	3.64
	02	0.8	1.7	0.9		
	03	1.7	2.6	0.9		
OS-13	01	00	1.1	1.1	1.03	4.36
	02	1.1	2.0	0.9		
	03	2.0	3.1	1.1		

BS = Brand Salt, OS = Open Salt

3.3 Discussion

Now – a – days IDD is marked as one of the prominent public health problem of the world. About one third of world population is exposed to the risk of iodine deficiency disorders. About 187 millions of world population (2.7% of the world population) was end up with goiter in 2010 (51). The government of Bangladesh is committed to eliminate IDD from Bangladesh and adopt USI strategy to fulfill their commitment. The first National IDD survey in Bangladesh was done in 1993 which show low level of iodine intake by 2/3 of total population of Bangladesh and existence of goiter in 47% of total population. On a response to this public health threat Bangladesh government passed iodized salt legislation in mid 1990s and recently. Infrastructure of salt iodization has been established freely in 267 salt purification factories with the help of UNISEF and Ministry of Health and Family, Bangladesh. This helped Bangladesh to achieve remarkable progress in the elimination of IDD. Massive success of Bangladesh government in the sustainable elimination of IDD was reflected on National Survey report 2004-05. The survey report said the goiter rate was fallen down to 6.2% which was way too down than 47% in 1993. In addition to this the median urinary iodine concentration was 163µg/L which was 53µg/L in 1993. However, the report showed 51.2% household coverage with adequately iodized salt. Bangladesh National Nutrient Survey 2012, published a preliminary report which give some satisfied news about the consumption of adequately iodized salt (≥15 ppm) by 57.6% households, consumption of salt with some iodine (≥5 ppm) by 80.3% of households and packets salt was consumed by 75.8% of households. In 2009-2010 periodic times Bangladesh produced 1.71 million MT of salt when the national demand of salt was 1.33 million MT. The demand of salt for human consumption or the demand of iodized salt was 0.87 million MT from the total demand of salt in 2009-2010 year period. Bangladesh government banned the manufacturing and selling of non iodized salt for human consumption by making a law in 1989 and in 1994 a gazette had been published about this fact. However, health bulletin 2013 gave some shocking news claiming that 30% of rural household still use 'open salt' for their consumption purpose. The use of open salt is 37% in poorest households and 17% in richest households of rural areas. Rural people use this 'open salt' because this 'open salt' as it is much cheaper than the packaged salt. In National Salt Policy, 2011 government has talked about the improvement of salt iodization, increase of salt production and development of salt industry, they talked about the law which banned the production and selling of non iodized salt throughout Bangladesh but they missed the part about the way of implementing this law, they missed the topic about monitoring the market place and selling of salts. Lack of market monitoring and implementation of law created a great chance for non iodized salt producer and seller to sell non iodized salt for human consumption in rural areas which is illegal work and crime according to 1989 salt law (health Bulletin, 2013; Vos, T., et al. 2010; IDDnews letter, 2013; National salt policy, 2011).

Moreover, recently government doesn't have any awareness campaign on iodine deficiency disorders. Mass people only know about goiter but they are completely unaware about any other iodine deficiency disorders and complications that may arise before and after birth of a child.

CONCLUSION

Bangladesh has achieved enormous success in eliminating iodine deficiency disorders from the country. Because of right decision and quick response in case of this demonic public health issue helped Bangladesh to achieve this success. Now, Bangladesh is able to meet up country's iodized salt demand by applying new improved method in salt production. Government with the help of UNISEF established new salt iodization infrastructures in 267 salt purification factories. Government also supply new technique and improved methods for ideal salt iodization. Salt farmers are motivated by the government to use new plastic bag salt production method leaving their old muddy salt production method. Government is also encouraging the people to involve themselves in salt production business and increase the production of iodized salt. Salt producers also get help from the government in marketing and selling of these iodized salts. Government has also made law for ensuring no production and selling of non-iodized or poorly iodized salt for human consumption and made available packed iodized salt for mass people's use. Despite of government's these enormous efforts of eliminating IDD from the country still we are lagging behind in 100% elimination of IDD. Still a big percent of rural people use poorly iodized or non iodized 'open salt' in their daily foods, still poorly iodized or non iodized salts are produced and sold in village markets claiming that those are iodized salt and human consumable. However their claim of iodized salt in some cases are true but these salts are poorly iodized and they contain less than required iodine level which doesn't help anyone in meet up their daily iodine requirements. Rural people are completely unknown about this fact and they prefer these 'open salts' over adequately iodized packaged salt due to low price of open salts. People are aware ofgoiter that is a common iodine deficiency disorder but they don't have any knowledge about other iodine deficiency disorders, even they are completely unaware about the daily requirements of iodine for their body. In addition to this, most of the rural people live below the poverty line and when he find out the price difference between so called iodized 'open salt' and adequately iodized packet salt then they go for the cheaper one. So-called iodized open salts are sold in village market at 10-15 BDT per kg, whereas adequately iodized packet salts are sold at 25 BDT per kg. Many rural people save this 10-15 BDT by buying open salts and invest this saved money in buying more rice for his family or buy some sweets or any toys for his loving children. Government should take necessary actions to minimize this price difference.

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